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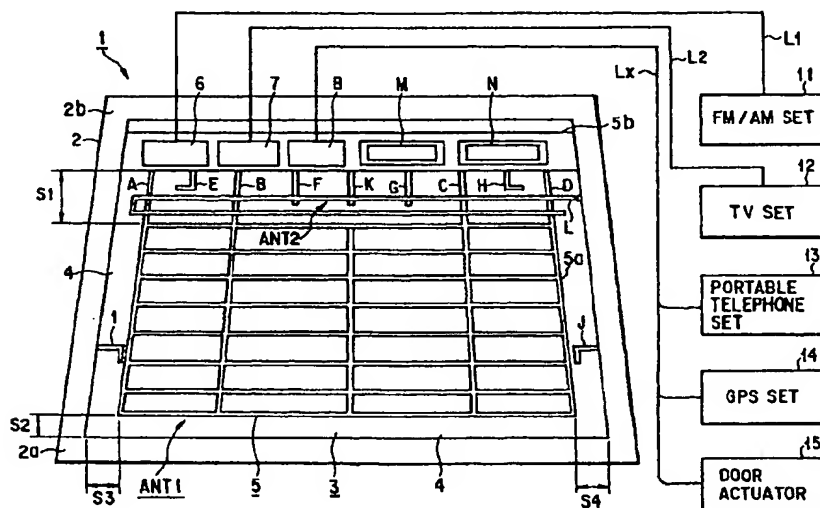
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**(54) All-around vehicle antenna-apparatus**

(57) In an all-around vehicle antenna apparatus according to the present invention, a window frame (2) of a vehicle window (1) is made of metal, a thin-film conductor (5) is formed on the surface of a translucent member (e.g., glass) (3) of the vehicle window (1) to form a slot (4) between the window frame (2) and thin-film conductor (5), and the slot (4) functions as a slot antenna

element. A plurality of thin-film conductor pieces (A to H, K, L) are arranged such that at least part of the pieces (A to H, K, L) is inserted into the slot (4) so as to have a specific relationship with the slot antenna element, and thus the thin-film conductor pieces (A to H, K, L) serve as a plural-wave-receivable antenna element adapted to a specific frequency.

**FIG. 1****EP 0 899 811 A2**

## Description

[0001] The present invention relates to an all-around vehicle antenna apparatus mounted on a vehicle such as an automobile and, more particularly, to an improvement in an antenna apparatus constituted mainly of a slot antenna provided on a vehicle window.

[0002] In a conventional windowpane antenna apparatus provided on a vehicle window, a long, narrow thin-film conductor having a predetermined pattern, which is to be formed on the window surface, is used as an antenna element. This antenna element is connected to a transmitter/receiver set via a feeder.

[0003] Since, in the windowpane antenna apparatus, a metal window frame serves as a grounding conductor, its shape has influence upon antenna characteristics. Usually the shape of a metal window frame greatly varies from vehicle to vehicle; therefore, even though an antenna element is formed with great precision so as to have a given size and a given shape, the antenna characteristics are greatly varied with the type of a vehicle on which the antenna element is to be mounted, with the result that a desired antenna characteristic cannot be obtained appropriately. To mount the above windowpane antenna apparatus on a vehicle, it is necessary to form a pattern for each antenna element in order to match the shape of a window frame of every vehicle, thus causing a drawback of making it difficult to manufacture the antenna element, and increasing in manufacturing costs.

[0004] It is accordingly an object of the present invention to provide an all-around vehicle antenna apparatus, which is capable of always stably fulfilling a desired antenna characteristic without exerting no influence upon the shape of a window frame though it has a fixed size and a fixed shape and is provided on a vehicle window.

[0005] To attain the above object, the all-around vehicle antenna apparatus according to the present invention has the following structures. The other characteristic structures will be clarified later in the embodiment of the present invention.

[0006] According to one aspect of the present invention, there is provided an all-around vehicle antenna apparatus, which includes a first means for forming a slot antenna element in a vehicle window having a window frame in which a translucent member is fitted and a second means for forming a plural-wave-receivable antenna element having a specific relationship with the slot antenna element in the vehicle window,

the first means comprising means for making the window frame of the vehicle window of metal, means for providing a thin-film conductor on the translucent member of the vehicle window to form a predetermined slot between the window frame and the thin-film conductor, and means for causing the slot to function as the slot antenna element, and the second means comprising means for arranging

a plurality of thin-film conductor pieces such that at least part of the thin-film conductor pieces is inserted in the slot so as to have a specific relationship with the slot antenna element, and means for causing the plurality of thin-film conductor pieces to function as the plural-wave-receivable antenna element adapted to a specific frequency.

[0007] This summary of the invention does not necessarily describe all necessary features so that the invention may also be a sub-combination of these described features.

[0008] The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a view of the structure of an all-around vehicle antenna apparatus according to one embodiment of the present invention; and

FIG. 2 is a block diagram of an electric system of the all-around vehicle antenna apparatus shown in FIG. 1.

(Embodiment)

[0009] Referring to FIGS. 1 and 2, one embodiment of the present invention will now be described. In FIG. 1, reference numeral 1 denotes a rear window of a vehicle. The window 1 has a window frame 2 made of metal and a translucent member 3 formed of a windowpane or the like. A thin-film conductor 5 is provided on the surface of the translucent member 3. A slot 4 having a predetermined width is formed between the window frame 2 and thin-film conductor 5.

[0010] The thin-film conductor 5 is constituted mainly of a defogger 5a for preventing the rear window 1 from being fogged. Between the defogger 5a and an upper frame 2b of the window frame 2, a relatively broader belt-shaped conductor 5b is formed in parallel with the upper frame 2b. The width S1 of the upper edge of the slot 4 between the defogger 5a and belt-shaped conductor 5b, is set to about 4 cm, while the width S2 of the lower edge thereof and the widths S3 and S4 of both sides thereof are each set to about 1 cm to 2 cm. Thus, a slot antenna element ANT1 mainly including the slot 4 is formed on the surface of the rear window 1.

[0011] A plurality of thin-film conductor pieces A to H, K and L are arranged in such a manner that at least part of the pieces is inserted in the slot 4 so as to have a specific relationship with the slot antenna element ANT1. Of these thin-film conductor pieces, the pieces A to D are directly connected to the defogger 5a and supplied with power, and the pieces E to H, K and L are electrostatically coupled to the defogger 5a and supplied with power. Thus, each of the conductor pieces A to H, K and L functions as a plural-wave-receivable antenna element ANT2 adapted to a specific frequency.

[0012] In the foregoing embodiment, the thin-film con-

ductor pieces A to D constitute a 4-channel FM antenna element, and the thin-film conductor pieces E to H constitute a 4-channel TV antenna element. Moreover, the piece K constitutes a key-less door lock/unlock antenna element, and the piece L constitutes an AM antenna element.

[0013] Small-sized slot antenna elements M and N adapted to a specific frequency are formed on the belt-shaped conductor 5b. The antenna element M constitutes a 1.5 GHz GPS (Global Positioning System) antenna element, and the antenna element N constitutes an 800 MHz portable telephone antenna element.

[0014] The belt-shaped conductor 5b is provided with auxiliary devices 6, 7 and 8 including an amplifier circuit for amplifying a signal input to the antenna apparatus and a matching circuit. The antenna elements constituted of thin-film conductor pieces are connected to their respective transmitter/receiver sets via the auxiliary devices 6, 7 and 8. For example, the thin-film conductor pieces A to D for the FM antenna element and the thin-film conductor piece L for the AM antenna element are connected to an FM/AM set 11 through the auxiliary device 6 and line L1. Similarly, the thin-film conductor pieces E to H for the TV antenna element are connected to a TV set 12 through the auxiliary device 7 and line L2. The other antenna elements, i.e., the small-sized slot antenna elements M and N serving as the GPS antenna element and the portable telephone antenna element, respectively, and the thin-film conductor piece K for the key-less door lock/unlock antenna element, are connected to a portable telephone set 13, a GPS set 14, and a door actuator 15 through the auxiliary device 8 and line Lx.

[0015] Matching elements I and J of slot antenna element ANT1 are inserted in the slot 4 between the window frame 2 and thin-film conductor 5. If the matching elements I and J are adjusted in advance, the impedance matching of the slot antenna element ANT1 can be obtained.

(Features of the Invention)

#### [0016]

[1] An all-around vehicle antenna apparatus according to the embodiment of the present invention includes a first means for forming a slot antenna element ANT1 in a vehicle window 1 having a window frame 2 in which a translucent member 3 is fitted and a second means for forming a plural-wave-receivable antenna element ANT2 having a specific relationship with the slot antenna element ANT1 in the vehicle window 1.

The first means comprises:

means for making the window frame 2 of the vehicle window 1 of metal;  
means for providing a thin-film conductor 5 on

the translucent member 3 of the vehicle window 1 to form a predetermined slot 4 between the window frame 2 and the thin-film conductor 5; and

means for causing the slot 4 to function as the slot antenna element ANT1.

The second means comprises:

means for arranging a plurality of thin-film conductor pieces A to H, K and L such that at least part of the thin-film conductor pieces is inserted in the slot 4 so as to have a specific relationship with the slot antenna element ANT1; and  
means for causing the plurality of thin-film conductor pieces A to H, K and L to function as the plural-wave-receivable antenna element ANT2 adapted to a specific frequency.

[2] In the all-around vehicle antenna apparatus as described in the above item [1], the slot antenna element ANT1 has matching elements I and J between the window frame 2 and the thin-film conductor 5.

[3] In the all-around vehicle antenna apparatus as described in the above item [1], the plural-wave-receivable antenna element ANT2 constituted of the thin-film conductor pieces A to H, K and L includes FM antenna elements A to D having a plurality of channels, TV-antenna elements E to H having a plurality of channels, a key-less door lock/unlock antenna element K, and an AM antenna element L.

[4] In the all-around vehicle antenna apparatus as described in the above item [1], the thin-film conductor 5 is constituted of a defogger 5a.

[5] In the all-around vehicle antenna apparatus as described in the above item [4], a belt-shaped conductor 5b is formed in parallel with the window frame 2 between the window frame 2 and the defogger 5a.

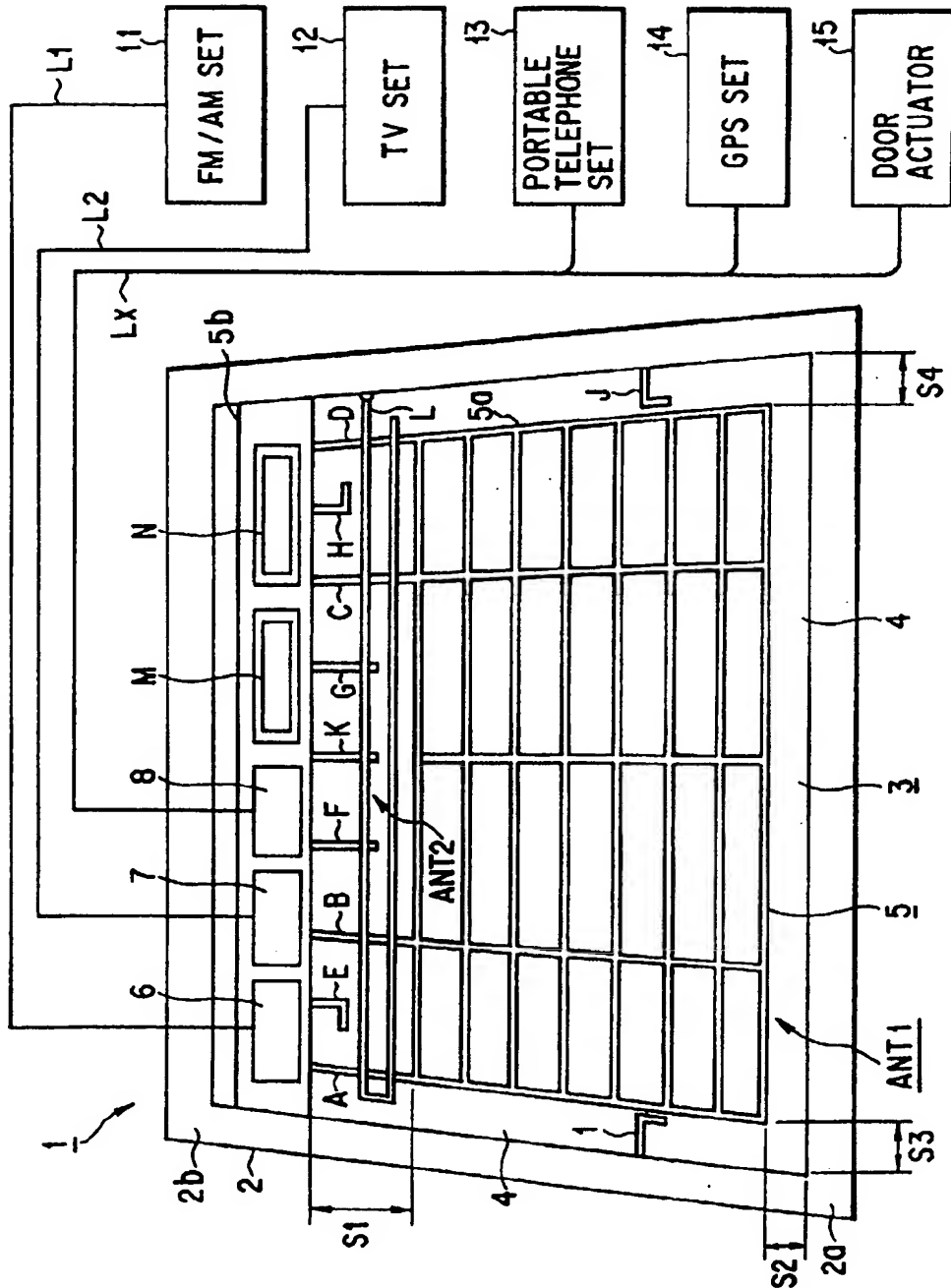
[6] In the all-around vehicle antenna apparatus as described in the above item [5], the belt-shaped conductor 5b is provided with auxiliary devices 6, 7 and 8 such as an amplifier circuit.

[7] In the all-around vehicle antenna apparatus as described in the above item [5], the belt-shaped conductor 5b is provided with small-sized slot antenna elements M and N adapted to a specific frequency.

[8] In the all-around vehicle antenna apparatus as described in the above item [7], the small-sized slot antenna elements M and N includes a portable telephone antenna element and a GPS antenna element.

**Claims**

1. An all-around vehicle antenna apparatus includes a first means for forming a slot antenna element (ANT1) in a vehicle window (1) having a window frame (2) in which a translucent member (3) is fitted and a second means for forming a plural-wave-receivable antenna element (ANT2) having a specific relationship with the slot antenna element (ANT1), in the vehicle window (1),
  - the first means comprising:
    - means for making the window frame (2) of the vehicle window (1) of metal;
    - means for providing a thin-film conductor (5) on the translucent member (3) of the vehicle window (1) to form a predetermined slot (4) between the window frame (2) and the thin-film conductor (5); and
    - means for causing the slot (4) to function as the slot antenna element (ANT1), and
  - the second means comprising:
    - means for arranging a plurality of thin-film conductor pieces (A to H, K and L) such that at least part of the thin-film conductor pieces (A to H, K and L) is inserted in the slot (4) so as to have a specific relationship with the slot antenna element (ANT1); and
    - means for causing the plurality of thin-film conductor pieces (A to H, K and L) to function as the plural-wave-receivable antenna element (ANT2) adapted to a specific frequency.
2. The all-around vehicle antenna apparatus according to claim 1, characterized in that the slot antenna element (ANT1) has matching elements (I and J) between the window frame (2) the thin-film conductor (5).
3. The all-around vehicle antenna apparatus according to claim 1, characterized in that the plural-wave-receivable antenna element (ANT2) constituted of the thin-film conductor pieces (A to H, K and L) includes FM antenna elements (A to D) having a plurality of channels, TV-antenna elements (E to H) having a plurality of channels, a key-less door lock/unlock antenna element (K), and an AM antenna element (L).
4. The all-around vehicle antenna apparatus according to claim 1, characterized in that the thin-film conductor (5) is constituted of a defogger (5a).
5. The all-around vehicle antenna apparatus according to claim 4, characterized in that a belt-shaped conductor (5b) is formed in parallel with the window frame (2) between the window frame (2) and the defogger (5a).
6. The all-around vehicle antenna apparatus according to claim 5, characterized in that the belt-shaped conductor (5b) is provided with auxiliary devices (6, 7 and 8) such as an amplifier circuit.
7. The all-around vehicle antenna apparatus according to claim 5, characterized in that the belt-shaped conductor (5b) is provided with small-sized slot antenna elements (M and N) adapted to a specific frequency.
8. The all-around vehicle antenna apparatus according to claim 7, characterized in that the small-sized slot antenna elements (M and N) includes a portable telephone antenna element and a GPS antenna element.



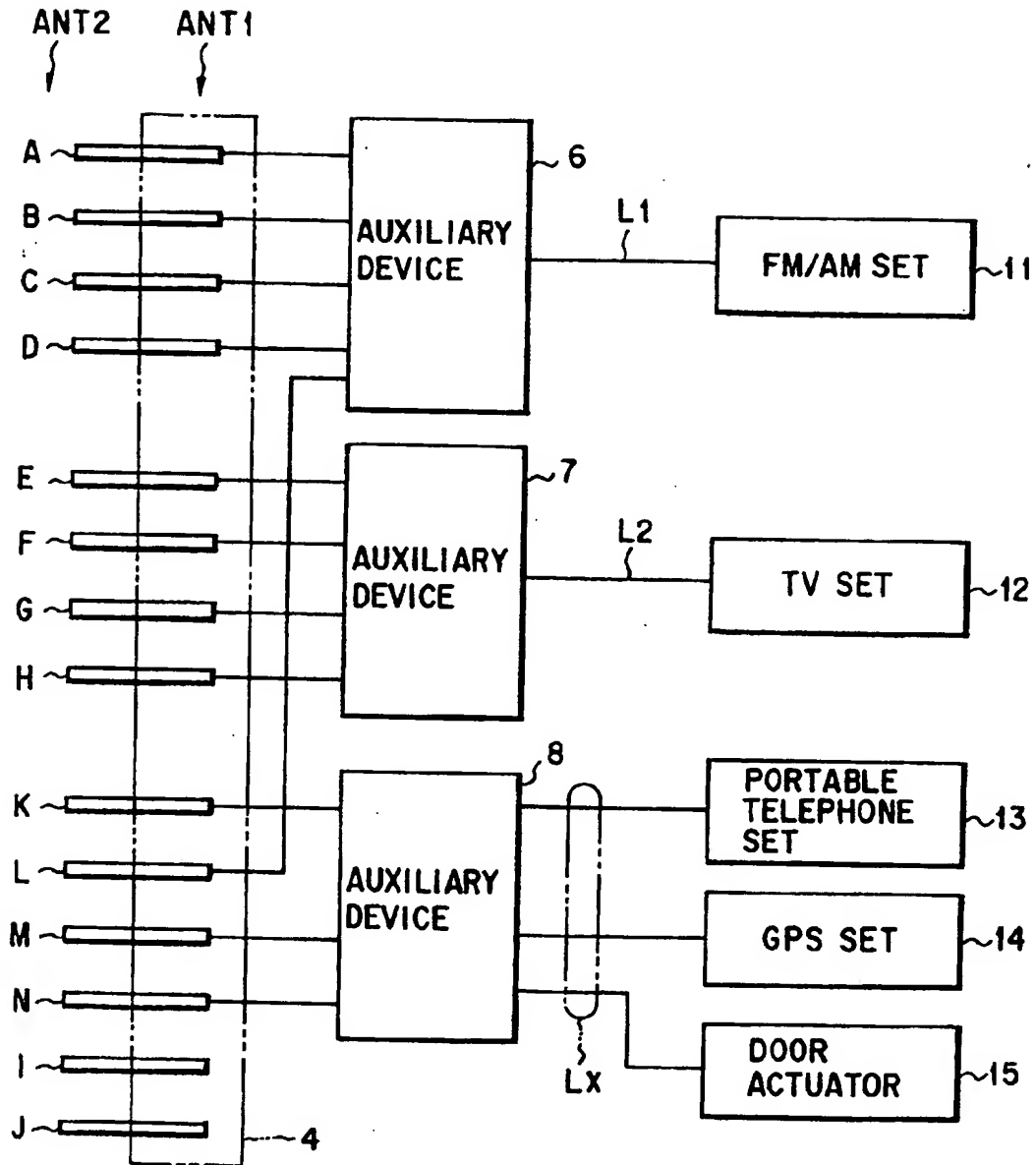


FIG. 2